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METHOD, DATA FORMAT, ENCODING DEVICE, DECODING DEVICE AND SYSTEM

Background Information

The present invention is based on a method, a data format, an encoding device, a decoding device and a system for encoding, for decoding and/or for transmitting location information according to the species defined in the alternative independent claims. Many formats for digital maps are already known, in particular proprietary or standardized ones. An example of a standardized map is the GDF format. Moreover, proposals have been made for the most different georeferencing methods.

Advantages of the Invention

The inventive method, data format, encoding device, decoding device and system having the features of the alternative independent claims has the advantage over the background art that geographical objects of arbitrary complexity can be efficiently encoded, interpreted and transmitted. In this connection, it is ensured that geometry-oriented data and description-oriented attributes are clearly distinguished. Moreover, this advantageously allows map segments to be encoded, decoded and/or transmitted as well, the map segments being geometrically open or closed, for example, in the form of meshes. Because of this, the geometric representations can be read out in a single sequence, that is "in one piece". Furthermore, this results in that a division of referencings and applications is attainable, i.e., the location information encoded according to the present invention is optionally evaluated, on one hand, mainly by its geometry-oriented information, i.e., in particular by its coordinate chains, the attribute-oriented description information playing a minor role or, on the other hand, primarily in an application-oriented manner, i.e., with respect to its

attribute information.

Moreover, it is an advantage that the locating information includes at least one first coordinate chain, the coordinate chain including at least one first, in particular geographical point. Through this, it is possible for a locating information to be encoded, decoded and/or transmitted with a small encoding outlay and with high accuracy.

It is a further advantage that the first coordinate chain contains a second point, the first point of the first coordinate chain being specified in absolute coordinates and the second point of the first coordinate chain being specified in relative coordinates, in particular with respect to a centroid coordinate or with respect to the first point of the first coordinate chain. Through this, it is possible for location information to be encoded, decoded and/or transmitted also in the form of a serial representation along the coordinate chains. In this manner, moreover, it is possible to attain an efficient encoding of the locating information, advantageously resulting in a smaller outlay, such as less memory requirements for the encoding, such as smaller bandwidth requirements for the transmission, and for the decoding.

A further advantage lies in that the first point of the first coordinate chain is interpreted in a defined direction via the second point of the first coordinate chain. Thus, a directional information results from the serial arrangement of the plurality of points of a coordinate chain.

Another advantage is that the first point of the first coordinate chain is interpreted in a defined direction via the second point of the first coordinate chain. Due to the sequence of points defining a coordinate chain, a defined directional information is given which ensues from the structure of the coordinate chain and can be evaluated.

It is also advantageous that the description information includes at least one first attribute field. Through this, it is possible for the most different kinds of other information to be encoded, decoded and transmitted in addition to the pure locating information in the form of coordinate chains.

A further advantage consists in that the first attribute field includes a type specification and description data, the description data being determined by the type specification, in particular with respected to the name, accuracy, direction, time, a POI (point of interest) and/or to the physical link. In this manner, it is also possible, for example, to specify an accuracy information in a variable manner over a coordinate chain. In this manner, moreover, it is possible to establish a link between different coordinate chains by providing a description type "physical link".

With this, it is also possible, for example, for entire networks of location information to be encoded, decoded and/or transmitted via the inventive method, data format, encoding device, decoding device and system. In this context, such a physical link between coordinate chains can correspond, for example, to a branch.

It is likewise advantageous that the assignment information includes at least one first assignment entry, the first attribute field and the first point of the first coordinate chain being assigned to each other via the first assignment entry. Because of this, the assignment information can advantageously be provided symmetrically, i.e., due to the assignment information, it is possible to search the location information both for coordinates or coordinate chains and for attribute fields contained in description information. Thus, the method and the data format according to the present invention are suitable both for geometry-oriented georeferencing methods and for attribute-oriented georeferencing methods.

Another advantage is that the first assignment entry includes both a reference to the first attribute field and a reference to the first point of the first coordinate chain. Because of this, it is possible to establish exactly one link between a point of a coordinate chain (i.e., a so-called "chain link") and an attribute field, i.e., description data or a type specification via an entry in the assignment information (reference table). By adding a further entry to the list of assignment information, i.e., to the reference table, it is possible to establish a further link between a point of a coordinate chain and an attribute field, however, it being required for at least one reference to be different from all other entries in the list of assignment information, i.e., either a different point from the set of locating information is referenced in the case of the further entry in the list of assignment information or a different attribute field of the description information is referenced.

Moreover, it is an advantage that the first assignment entry includes either both a reference to the first attribute field and a reference to a plurality of points of coordinate chains of the locating information, or both a reference to a plurality of attribute fields and a reference to the first point of the first coordinate chain. Due to this, it is possible for the assignment information to be simplified, thus attaining a more compact encoding of the location information, by carrying out an appropriate grouping of entries in the list of the assignment information. This is possible, for example, by combining entries having the same attribute reference or by combining entries having a successive set of points within a single coordinate chain.

Another advantage consists in that the data packet includes a header part of the location information and data part of the location information. This permits a separation between pure pattern information of the whole data block and the information which is actually to be encoded, decoded and/or

transmitted.

A further advantage lies in that the header part includes structure information and interpreting instructions, the structure information specifying the data structure of the location information, and the interpreting instructions specifying the purpose of the location information. This permits, in particular during the decoding of the location information, a faster and more efficient processing by sorting out location information which is irrelevant for a specific purpose of processing.

Furthermore, it is an advantage that the definition of at least the first point of the first coordinate chain is definable as a function of a location information query. Due to this, the location information can be individually and flexibly geared to the location information query.

Moreover, it is advantageous that the location information is at least partially correlatable with data of a first data base which is assigned to the decoding device. This results in an increase in the encoding efficiency of the location information because at least a part of the required location information exists already in the first data base.

It is a further advantage that the location information which is not contained in the first data base and/or for which no correlation with data of the first data base is possible is stored in a second data base assigned to the decoding device. According to the present invention, it is thus especially possible for the inventory of data in the first and/or the second data base assigned to the decoding device to be extended, updated and/or completed, which increases the overall effectiveness of the method and of the system since identical queries at successive points in time as a result of which identical location information would be transmitted can be avoided in this manner.

Drawing

An exemplary embodiment of the present invention is depicted in the drawing and will be explained in greater detail in the following description.

Figure 1 shows a system according to the present invention having an encoding device and a decoding device for encoding, for decoding and/or for transmitting location information;

Figure 2 depicts a system according to the present invention having a transmitter and a receiver of location information;

Figure 3 represents a system according to the present invention having two transmitter-receivers of location information;

Figure 4 shows a data packet according to the inventive data format for encoding, for decoding and for transmitting location information; and

Figure 5 is a representation of the information content of a data packet.

Description of the Exemplary Embodiment

Figure 1 shows a system 1 according to the present invention for encoding, for decoding and/or for transmitting location information. System 1 according to the present invention includes an encoding device 20 and a decoding device 60. Encoding device 20 transmits at least one data packet 400 to decoding device 60 via a transmission path. Associated with decoding device 60 is a first data base 62, decoding device 60 drawing on data stored in first data base 62 when decoding data packet 400. Decoding device 60 delivers a decoding result

600 as the result of the decoding of data packet 400. In a particularly advantageous embodiment of the present invention, provision can be made for decoding result 600 to be entirely or partially stored in a second data base 64 which is likewise associated with decoding device 60. In a further advantageous embodiment of the present invention, moreover, provision is made for the data stored in second data base 64 to be utilized together with the data stored in first data base 62 for decoding data packet 400 in decoding device 60. The optional existence of second data base 64 and the optional use of the data stored in second data base 64 for decoding data packet 400 are represented in Figure 1 by broken arrows pointing from decoding result 600 to second data base 64 and from second data base 64 to decoding device 60, respectively.

In this context, provision is made for the transmission path to be an arbitrary transmission path. According to the present invention, this will be understood both as a wire-bound and a wireless transmission. However, provision is made, in particular, to implement a wireless transmission of data packet 400 via a radio link. In this context, moreover, provision is made, in particular, to use a radio link according to a standard for wireless data transmission such as DECT, GSM, UMTS, GPRS, infrared. For the wireless transmission of data packet 400, provision is made, in particular, for a transmission via an IP network, for example, via the Internet.

According to the present invention, first data base 62 is provided, in particular, as a read-only memory, in particular as a CD-ROM, magnetic tape, magneto-optical disk, or the like, second data base 64 being provided as a rewritable memory. However, in an advantageous embodiment of the present invention, provision can also be made for first and second data base 62, 64 to be physically combined in a single memory which is provided, for example, as a write-read memory throughout or which is provided as a read-only memory in a first part, corresponding to a use as first data base 62, and

as a write-read memory in a second part, corresponding to a use as second data base 64.

In system 1 according to the present invention, moreover, provision is made for a third data base 22 to be associated with encoding device 20. In this context, third data base 22 is either designed as a read-only memory or as a write-read memory, depending on the use of third data base 22. For instance, if provision is made that for encoding data packet 400 in encoding device 20, only statistical information is required from third data base 22, it can be advantageous for data base 22 to be designed as a read-only memory, for example, as an optical or magneto-optical disk, in particular for reasons of cost.
On the other hand, it can be useful to provide third data base 22 either entirely or partially as a write-read memory so that current data can be written the into third data base, preferably at regular intervals, the current data, together with the "old data inventory" being allowed for in the encoding of data packet 400 in encoding device 20.

The cause for the encoding of data packet 400 via encoding device 20 is given according to the present invention, in particular in that a location information query 200 is fed to encoding device 20. However, provision can also be made for encoding device 20 to encode data packet 400, for example at regular intervals, and to transmit it to decoding device 60, it being obvious that, in each case, the information content of data packet 400 is generally different in this regular sequence of transmission operations.

Figure 2 depicts a system 1 according to the present invention, including a transmitter 5 and a receiver 10 of location information. In this context, transmitter 5 transmits data packet 400 to receiver 10. To this end, provision is made for an encoding device 20 either to be provided in transmitter 5, possibly with a third data base 22 associated therewith, or

for such an encoding device 20 to be assigned to transmitter 5. Accordingly, provision is made for a decoding device 60 according to the present invention to be either integrated in or assigned to receiver 10. In these two cases, decoding device 60 according to the present invention then optionally includes first data base 62 and/or second data base 64.

In Figure 2, transmitter 5 can represent, for example, a service provider who transmits data packet 400 to the users of a corresponding service in the form of a broadcast transmission. In this case, receiver 10 constitutes such a user of a service made available by the service provider. The mentioned services include, in particular, navigation and/or traffic information services. According to the present invention, location information receiver 10 depicted in Figure 2, in particular as a user of a service that either requires or provides the transmission of location information, is in particular a land vehicle or watercraft, or a user who needs a location information.

Figure 3 shows system 1 according to the present invention, including a first transmitter-receiver 6 and a second transmitter-receiver 7. In this context, provision is made in Figure 3 for both the first transmitter-receiver to transmit information in the form of data packet 400 to second transmitter-receiver 7 and for second transmitter-receiver 7 to transmit information in the form of data packet 400 to first transmitter-receiver 6. Of course, the information content of the respective data packets 400 is generally different, depending on whether data packet 400 is transmitted from the first transmitter-receiver to the second transmitter-receiver or vice versa.

In an exemplary embodiment, second transmitter-receiver 7 is designed as a motor vehicle which needs a specific navigation or traffic telematics service so that location information, for example, on the most favorable traffic route to be

selected in a given traffic jam or traffic flow situation in the affected road network is needed by second transmitter-receiver 7. To this end, second transmitter-receiver 7 transmits data in the form of data packet 400 to first transmitter-receiver 6 which is designed, for example, as a service provider for navigation or traffic telematics services. Data packet 400 received by first transmitter-receiver 6 contains, for example, a location information on the starting and the destination position of second transmitter-receiver 7. Subsequently, data is encoded which is transmitted from first transmitter-receiver 6 to second transmitter-receiver 7 as data packet 400, this data packet 400 containing the routing which is most favorable at the time of encoding.

As a further application case of the present invention, provision is made that a user, via a navigation system, places a query with a service provider regarding the nearest parking garage since the data base which is available to the user, for example in the navigation system, does not provide any information on parking garages. To this end, the user's own position is transmitted to the service provider. According to the present invention, this own position is ascertained from the data base of the navigation system on the user side but can also be determined, for example, via GPS (global positioning system). The service provider transmits data packet 400 to the user, the data packet having an information content which enables the navigation system on the user side to find the parking garage. According to the present invention, it is possible in this connection, on one hand, to send information to the service provider about which navigation system and which data base (in particular, which update status) are present on the user side and, on the other hand, provision is also made according to the present invention that such an information is not made available to the service provider and that during the encoding of data packet 400, useful assumptions are made on the data content of

the data base or on the navigation system of the user.

In Figure 3, thus, provision is made that both first transmitter-receiver 6 and second transmitter-receiver 7 each contain an encoding device 20 and a decoding device 60, possibly with data bases 22, 62, 64, assigned for this purpose. In this context, encoding device 20 of second transmitter-receiver 7 initially encodes data packet 400 which is transmitted from second transmitter-receiver 7 to first second transmitter-receiver 6. This data packet 400 is decoded in first transmitter-receiver 6 in decoding device 60 thereof, and is translated into location information query 200 which is thereupon made available to encoding device 20 of first transmitter-receiver 6. Data packet 400 to be transmitted from first transmitter-receiver 6 to second transmitter-receiver 7 is then encoded by encoding device 20 of first transmitter-receiver 6 and, after being transmitted to second transmitter-receiver 7, is decoded by decoding device 60 thereof, whereupon decoding device 60 of second transmitter-receiver 7 holds decoding result 600 ready for further use, for example, for display or storage.

Figure 4 represents the structure of data packet 400. The data format according to the present invention for coding, decoding and transmitting location information uses such data packets 400 for the transmission of the location information. Data packet 400 is divided into a header part 420 and a data part 440. Header part 420 includes on its part structure information 422 and, possible, interpreting instructions 424. Header part 420 is also denoted as header 420. The data structure of data packet 400 is specified in header 420 via structure information 422. The structural interpretation is ensured in this manner.

Interpretation instructions 424 serve to allow the data contents delivered in data packet 400 to be correctly interpreted as such. To this end, it is useful to furnish a

statement on the purpose of the content.
Useful at this point is, for instance, an information on whether the information content of data packet 400 is, for example, a subnetwork of a digital map, a POI (point of interest), a traffic jam warning, etc. The purpose of the data content of data packet 400 can be indicated, in particular, via a type catalog so that the different possible data contents can unequivocally be recognized.

Data part 440 of data packet 400 is always divided into locating information 450, description information 470, and assignment information 460. In this connection, provision is made according to the present invention that locating information 450 and description information 470 be present or transmitted within data packet 400 separately from each other, i.e., for instance, during the transmission of data packet 400 and, here in particularly of data part 440, for example, locating information 450 is transmitted first, then description information 470 and, after that, assignment information 460 or, these three information types are transmitted in a different order but not in a manner that they mixed among themselves.

Locating information 450 includes an arbitrary number of coordinate chains, for which are representatively indicated in Figure 4 a first coordinate chain 451 and a second coordinate chain 452. Specifically, provision is also made for locating information 450 to not include any coordinate chains 451, 452 and, consequently, that data part 440 of respective data packet 400 does not include any locating information 450. On their part, coordinate chains 451, 452 include an arbitrary number of points, a first point 454 of first coordinate chain 451, a second point 455 of first coordinate chain 451 and a third point 456 of first coordinate chain 451 being representatively indicated for the arbitrary number of points for first coordinate chain 451. Correspondingly, a first point 457 of second coordinate chain 452, a second point 458 of

second coordinate chain 452 and a third point 459 of second coordinate chain 452 are representatively indicated for the arbitrary number of points of second coordinate chain 452. In particular, provision is made for a coordinate chain to include only one point.

A directional information is given via the sequence of the points in coordinate chains 451, 452. The points of a coordinate chain generally denote a geographical point, this point generally being defined by coordinate data with respect to a coordinate network, for example, on the surface of the earth. In this connection provision is made according to the present invention, in particular that, for increasing the encoding efficiency, for example, first point 454 be specified in absolute coordinates for first coordinate chain 451 and that following points 455, 456 be specified only with relative coordinates with respect to first point 454. Another way is to specify a point of a coordinate chain by the difference coordinate to its preceding point, i.e., to specify the differential vector between the preceding point and the point to be defined. Moreover, it is also possible to generate a centroid coordinate for a coordinate chain, the centroid coordinate being specified in absolute coordinates, and to define the points relative to the centroid coordinate.

Description information 470 includes an arbitrary number of attribute fields for which are representatively indicated in Figure 4 a first attribute field 471, a second attribute field 472, and a third attribute field 473. Provision can also be made for description information 470 to not include any attribute fields so that data part 440 of respective data packet 400 does not include any description information 470. First attribute field 471 includes a type specification 474 of first attribute field 471 and description data 475 of first attribute field 471. Second attribute field 472 likewise includes a type specification 476 of the second attribute field and description data 474 of second attribute field 472.

In the same way, third attribute field 473 includes a type specification 478 of the third attribute field and description data 479 of the third attribute field. Type specifications 374, 476, 478 specify the type of information which is contained in the respective attribute fields 471, 472, 473. According to the present invention, this can be a name, a directional accuracy, a time, a POI (point of interest) and/or a physical link. The description data 475, 477, 479 is then the information which corresponds to the respective type specification.

For instance, description data 475, 477, 479 contains the indication of a time in an appropriate data format if corresponding type specification 474, 476, 478 contains the type of a time indication.

Further examples of description data 475, 477, 479 or type specification 474, 476, 478 include:

- "is desired object": an interpretation aid was already given in header part 420. The object which is actually to be referenced (i.e., one or a plurality of geometrical point(s) 454 to 459) can be explicitly marked as such as well.
- Objects are marked by their "possible use". Encoded for an object in description information 470 of data packet 400 is, for instance, the information that this object can be utilized only for representation but not for matching, that is for the correlation with data of a data base.
- Preferred points which a deemed to be important on the transmitter side should be markable as such.
- Provision is made for crossing points in a network of a digital map to be treated either as physical link or as a further category of the type "crossing".

Assignment information 460 includes an arbitrary number of assignment entries, for which are representatively indicated

in Figure 4 a first assignment entry 461 and a second assignment application 462. In particular, provision can also be made for assignment information 460 to not include any assignment entries so that data part 440 of the respective data packet does not include any assignment information 460. According to the present invention, assignment information 460 can be represented, in particular in the form of a table. In this context, each assignment entry includes a reference both to a point 454 to 459 and to an attribute field 471, 472, 473. In this manner, a link is established in the form of an assignment between a point 454 to 459 of a coordinate chain 451, 452 and the data of an attribute field 471, 472, 473. In this connection, according to the present invention, it is provided permitted both that an assignment entry 461, 462 a link be established between exactly one point 454 to 459 and exactly one attribute field 471 to 473 and it is also permitted that an assignment between a number of several points 454 to 459 and exactly one attribute field 471 to 473 or else between exactly one point 454 to 459 and a number of several attribute fields 471 to 473 be permitted. Due to this, the encoding efficiency is increased. This is given, in particular, by the mentioned combination of assignment entries which have the feature that the information content of their attribute field is identical or which have the feature that they refer to successive points. By grouping such "single assignment entries" into a single "group assignment entry", it is possible to attain a compression.

A reference to a point 454 to 459 of a coordinate chain 451, 452 is advantageously possible by specifying the number of coordinate chain 451, 452 and the list position of point 454 to 459 within the chain. According to the present invention, the reference to an attribute field is correspondingly given via its number or list position in an advantageous manner. Via assignment entries 461, 462, assignment information 460 is designed as a cross-referencing, which can advantageously be represented in tabular form.

If both locating information 450 and assignment information 460 as well as description information 470 do not contain any entries, respectively, data part 440 of respective data packet 400 is empty, which is also provided for by the present invention. In this case, this fact is encoded in header part 420 of data packet 400. In this context, structure information 422 of header part 420 contain, for example, data with respect to the length (for example, in bytes) of header part 420, data on the length (for example, in bytes) of interpreting instruction 422 of header part 420, data on the number of coordinate chains 451, 452 within locating information 450, and data on the number of points contained in each of the coordinate chains, data on the number of assignment entries 461, 462 within the assignment information 460 and data on the number and the respective length (for example, in bytes) of attribute fields 471 through 473 of description information 470. Via this structure data in header part 420 with respect to data part 440 of data packet 400, it is also possible to separately access individual information types of data part 440.

Figure 5 is a representation of the information content of a data packet 400. First coordinate chain 451 includes a number of points which are framed in Figure 5 by a first frame of broken lines which is provided with reference numeral 451. Included among the points of first coordinate chain 451 is, first of all, first point 454 of first coordinate chain 451, an arrow pointing from the first point to the second point (not marked) of first coordinate chain 451. From the second point of first coordinate chain 451, in turn, an arrow points to third point 456 of first coordinate chain 451, and from there to a fourth point (not marked) of coordinate chain 451, and so on. At third point 456 of first coordinate chain 451, second coordinate chain 452 branches off, the points thereof being framed in Figure 5 by a second frame of broken lines which is provided with reference numeral 452. From first point 457 of second coordinate chain 452, in turn, an arrow points

to the second point (not marked) of second coordinate chain 452, and from there further to the third point (not marked) of second coordinate chain 452. From the third point of second coordinate chain 452, an arrow points to a fourth point of second coordinate chain 452, the fourth point, in the example, at the same time being the last point of second coordinate chain 452 and indicating, for instance, a department store, a parking garage, in more general terms a POI (point of interest).

In the example shown in Figure 5, third point 456 of first coordinate chain 451 and first point 457 of second coordinate chain 452 mark the same geographical point. Thus, a physical link is established between these two points. The information on the physical link is stored in description information 470 of data packet 400 and is assigned to the two mentioned points 456, 457 via assignment information 460 of the data packet as described above. In this manner, it is possible, in particular, to encode, decode and transmit entire networks which correspond to digital maps, using the data format according to the present invention.

The encoding of data packet 400 will be understood especially as:

- the provision of the actual object, i.e., of the object which is requested especially via location information query 200, with a corresponding environment of locating or description information via a suitable retrieval, that is, via a correlation with the data of the data base on third data base 22;
- the transfer of the geometry representing this data into a suitable set of coordinate chains 451, 452 or, more generally, to a suitable set of location information 450;
- the transfer of relevant identifiers from third data base 22 into format-compliant attribute fields 471, 472, 473;
- the marking of relevant parts (for example, "is desired object", POI);
- the generation of assignment information 460, in

particular in the form of a cross-reference table;

- the generation of header 420 and data part 440.

In a simpler embodiment, however, the encoding can also include only a part of these steps. This is an advantage, in particular, where data packets 400 have to be encoded which are just standard ones or intended for a very specific purpose of application. This could be the case where a user, for example in a motor vehicle, interrogates traffic information with respect to a route to be traveled Here, it is sufficient during the encoding of data packet 400 which is to be transmitted from the user to a service provider, for example, via mobile telephony, to make provision for data packet 400 to transmit only the starting and destination coordinates along with the information that the coordinates are starting and destination coordinates.

The decoding of data packet 400 will be understood especially as:

- a comparison of the geometrical information contained in data packet 400 with the data content of first data base 62 and/or second data base 64 in connection with which, in particular, suitable correlation methods (matching) are used, resulting in a set of references to first and second data base 62, 64 associated with decoding device 60.

According to the present invention, provision is also made, in particular

- to carry out a geometrical consistency check for geometrical objects which are possibly to be newly connected;
- to carry out a retrieval on first and/or second data base 62, 64 along the lines of string comparisons, using the attributes existing, in particular, in description information 470 of the data packet, referenced to these data bases being expected as the result again;

- to carry out a crosswise check of the consistency between geometry-oriented information and description-oriented information via assignment information 460 of data packet 400;
- to store in second data base 64 geometry-oriented and/or description-oriented information, in particular, objects to be newly connected together with the references.